

TWR- 10162
REVISION K

RELIABILITY PLAN FOR SPACE SHUTTLE SOLID ROCKET MOTOR PROJECT

4 MARCH 1993

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Prepared for:

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RELIABILITY PLAN FOR
SPACE SHUTTLE SOLID ROCKET MOTOR PROJECT


DR No. 4-2

March 1993


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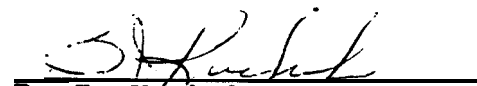
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- A 20 Dec 74 Document revised to incorporate NASA/MSFC comments contained in letter **SA41 (96-74)**, dated 9 October 1974.
- B 14 Apr 75 Document revised to incorporate NASA MSFC comments contained in letter EG23 (12.75), dated 21 Jan 1975 as amended by "**Minutes of Meeting with MSFC, JSC, and Thiokol Representatives Regarding the Reliability Plan for the Space Shuttle SRM Project, TWR-10162, Rev A dated 20 Dec 1974**". Document approval is authorized by letter **SA41-27-75**, dated 15 April 1975.
- C 31 Mar 76 Document revised to incorporate changes in response to the **SR&QA** audit of August 1975, clarify/update areas to reflect current operating methods, and make minor editorial changes.
- D 1 Apr 77 Document revised to incorporate changes per CDR RID MS-049.
- E Sept 85 Document completely revised to incorporate changes in the Wasatch Operations organization and in NASA data requirements document DPD 400, and to reflect current operating methods. This effort is in answer to an in-house audit finding ADR ARFS-17. Incorporated NASA comments by **including** a list of applicable documents (pg. vii-ix). This required deleting the mention of the Request for Proposal on pg. 7 and updating the Management Procedure on pg. 32. In addition, the Reliability Specification called out in **2.2.1**, pg. 20, was clarified. (MSFC letter **SA42-475-85**).
- F 16 Jan 89 Document revised to reflect separate Divisions within Morton Thiokol Inc. (MTI) and resulting organizational changes within **MTI** and the Systems Assurance Organization, and NASA compliance matrix comments. Mention of Reliability **Demonstration** Plan and a more detailed description of Liaison/Problem Reporting were added. Incorporated NASA comments to include hazard analysis on ground support equipment (GSE) in lieu of a FMEA/CIL. Plan is approved with these changes. (MSFC letter **SA42-565-88**).

Applicable Document List was updated to reflect latest documents **and** document numbers. Removed revision designation from all Thiokol documents.

Section 1.3 was updated to reflect changes in **Thiokol's** motivation and recognition programs.

Section 2.1.7 was updated to increase the interval for formal document submittal to NASA.

Section 2.2.2 was updated to show a clarification of the trade study preparation requirement.

Section 2.2.3 was updated to clarify the relationship between the **FMEA/CIL** and hazard analysis regarding ground support equipment.

All sections received an overall review to ensure consistency and accuracy. Redundant and unnecessary information was eliminated. More than 50 percent of the document was changed, therefore, no change bars were used.

FOREWORD

This plan describes the Reliability Program for the Redesigned Solid Rocket Motor (RSRM) Project. It serves as the control document for defining, implementing, and managing the RSRM reliability provisions specified in NHB 5300.4 (1D-2). This plan complies with the requirements in DPD 400, DR 4-2, under Contract No. **NAS8-38100**. The outline and format used herein were developed to be readily identifiable to the provisions of NHB 5300.4 (1D-2) and correspond to each section and subparagraph of Chapter 1, Introduction and Chapter 3, Reliability.

The requirement for use of the International System of Units is waived for this document.

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APPLICABLE DOCUMENTS LIST

I. GOVERNMENT DOCUMENTS

DPD 400 Revision D
Information Requirements Document - Space Shuttle
Program Solid Rocket Motor Project

Applicable Paragraphs: 1.1, 1.5, 2.1.2, 2.2.3,
2.2.6, 2.2.7

NHB 5300.4(1D-2)
Safety, Reliability, Maintainability, and Quality
Provisions for the Space Shuttle Program

Applicable Paragraphs: 1.0, 1.1, 2.0, 2.1, 2.1.2,
2.2.3

MIL-STD.975 G
NASA Standard Electrical, Electronic, and
Electromechanical (EEE) Parts List

Applicable Paragraphs: 2.2.8

MSFC-DWG-85M03-936 B
EEE Parts Selection and Application Guidelines for
the Space Shuttle External Tanks and Solid Rocket
Booster

Applicable Paragraphs: 2.2.8

NSTS 07700 Vol. x
Space Shuttle Flight and Ground System Specification

Applicable Paragraphs: 2.2.3,

NSTS 22206 Revision C
Instructions for Preparation of FMEA and CIL

Applicable Paragraphs: 2.2.3

NASA Memo **SA42-516-88-JT**
FMEA/CIL Requirement for GSE Certification

Applicable Paragraphs: 2.2.3

II. THIOKOL DOCUMENTS

**A. Management Policies/Procedures and Organization
Operating Instructions**

APPLICABLE DOCUMENTS LIST (CON.T)

STW7-3776

Reliability Requirements for Space Shuttle RSRM
Hardware, Components and Raw Material Subcontractors

Applicable Paragraphs: 2.1.3

TWR-10161

Quality Plan for the Space Shuttle Solid
Rocket Motor Project

Applicable Paragraphs: ~~1.2~~ 1.2.3

TWR-13880

SRM Operational Logistic Support Plan

Applicable Paragraphs: 1.2

TWR-15682

Performance and Preparation Procedures for RSRM
Project FMEA and CIL

Applicable Paragraphs: 2.2.3

TWR-15712

Failure Modes Effects Analysis (FMEA) and Critical
Items List (CIL) for the Space Shuttle Redesigned
Solid Rocket Motor (RSRM)

Applicable Paragraphs: 2.2.3

TWR-15902

Safety Plan for the Space Shuttle Redesigned Solid
Rocket Motor Project

Applicable Paragraphs: 1.2, 2.2.3

TWR-16461

Implementation Plan for Significant Problem
Reporting and Resolution Procedure

Applicable Paragraphs: 2.2.6

TWR-17499

Space Shuttle Redesigned Solid Rocket Motor COQ Data
Report

Applicable Paragraphs: 2.3.1

TWR-17866

RSRM Reliability Demonstration Plan

1.0 INTRODUCTION (REFERENCE CHAPTER 1 OF **NHB 5300.4 (1D-2)**)

1.1 **1D100--APPROACH**

This plan describes the activities and methods for fulfilling Thiokol Corporation's reliability commitment to the National Aeronautics and Space Administration (NASA). The described activities are a part of the **Redesigned Solid Rocket Motor (RSRM) Safety, Quality, and Reliability Assurance** effort, and are dedicated to ensure the cost-effective accomplishment of System Safety and Reliability Engineering functions. This plan applies to RSRM and related Government Furnished Equipment (GFE). The format of Chapters 1 and 3 of **NHB 5300.4 (1D-2)** (Safety, Reliability, Maintainability, and Quality Provisions for the Space Shuttle Program) was used in this plan.

A definition of the reliability program tasks and their relationships to the broad RSRM program requirements, as established by NASA, are shown in Table I. The program tasks for fulfilling these objectives are performed by, or task completion is ensured by, the System Safety organization. System Safety personnel also perform RSRM support tasks and analyses as directed by RSRM Program Management.

System Safety prepares the reports cited in section 1.5 for submittal to NASA. The data requirement description in DPD 400, Information Requirements Document,* serves as a guide for preparing the documents.

1.2 **1D101--RELATION TO OTHER CONTRACT AND PROGRAM REQUIREMENTS**

The reliability program tasks were developed to establish organizational responsibilities and ensure cost-effective task accomplishment (ref. Quality TNR-10161, Safety TWR-15902, and SRM Operational Logistic Support Plans TWR-13880). Similarly, other disciplines have coordinated their planned effort with System Safety.

1.3 **1D102--MOTIVATION AND GOALS**

The employee involvement section in Human Resources is responsible for administering all motivational/recognition programs. A description of these motivation/recognition programs is contained in the Recognition and Rewards Program Booklet which is distributed to all Thiokol Space Operations personnel. System Safety is an active participant in these motivational and quality enhancement programs.

Programs and goals are also communicated to Thiokol suppliers.

1.4 **1D103--INDEPENDENT EVALUATIONS FOR NASA**

Thiokol acknowledges NASA's right to designate other contractor representatives to act in NASA's behalf for the purpose of acquiring technical support and evaluating Thiokol's reliability activities.

1.5 **1D104--INFORMATION REQUIREMENTS LIST (IRL) AND INFORMATION REQUIREMENTS DESCRIPTIONS (IRD)**

System Safety prepares and submits, through RSRM Program Management, all DPD 400 documentation required by contract.

2.0 **RELIABILITY (CHAPTER 3 OF NHB 5300.4 (1D-2))**

2.1 **1D300--RELIABILITY MANAGEMENT**

The Reliability Engineering, Systems Assurance Operations Support, and Liaison/Problem Reporting Sections, under the direction of the System Safety Director, are responsible for performing reliability activities. These activities include the evaluation of hardware reliability through analysis, review, and assessment. Reliability activities including planning, effort authorization, and interfacing organization responsibilities are described in Space Operations Procedure 76-00-01.

The System Safety Director is responsible for reviewing and approving reliability planning, implementation, and documentation necessary to fulfill the

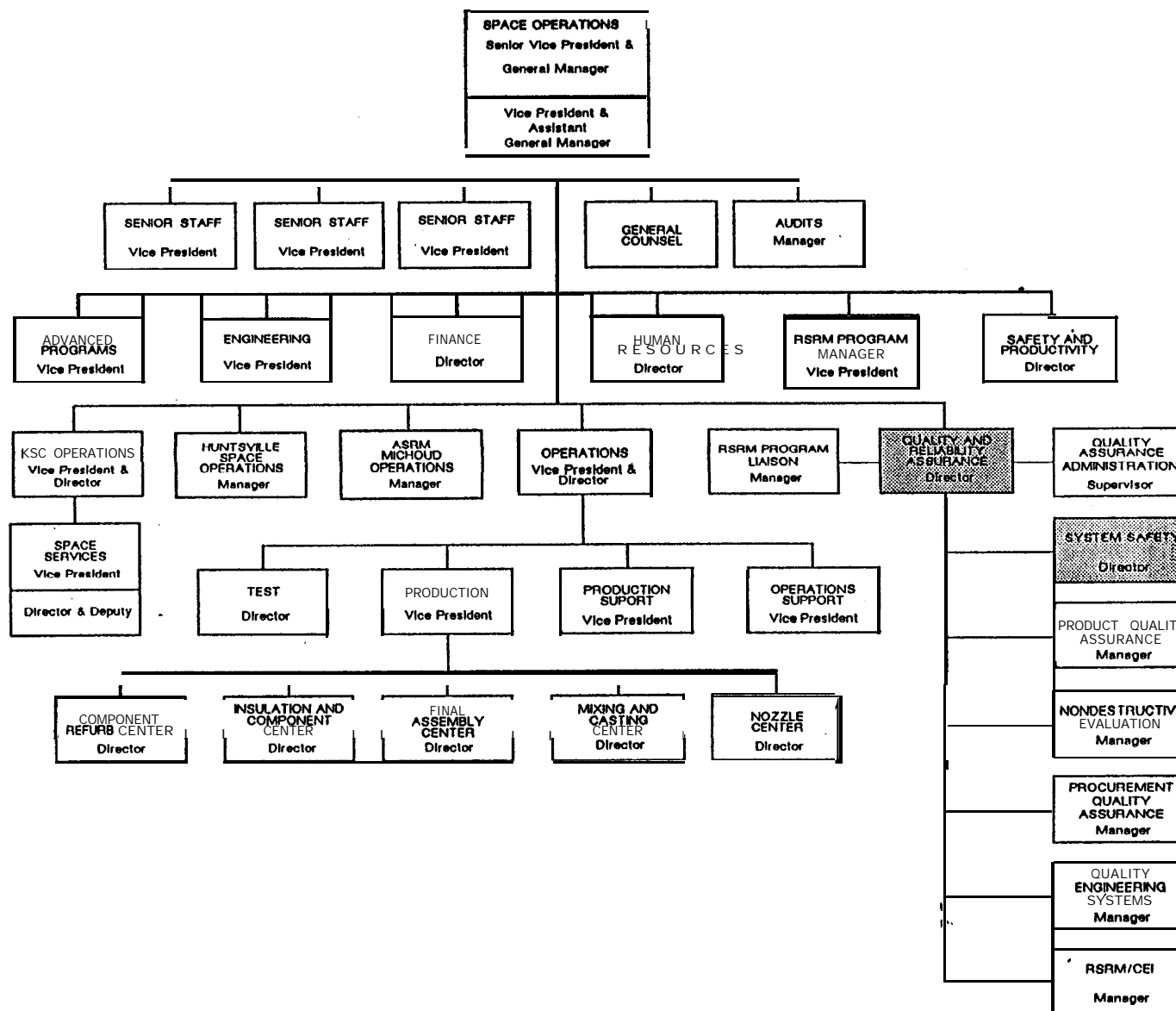


Figure 1. SYSTEM SAFETY RELATIONSHIP TO SPACE OPERATIONS

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c. Team surveys

2. Audits of Thiokol internal CIL controls
3. Audits of System Safety activities

The System Safety Audit Plan serves **as** the control document for defining, implementing, and managing System Safety related surveillance of both internal and subcontractor activities.

2.1.4 RELIABILITY PROGRESS REPORTING

The status of accomplishment ~~versus~~ planned effort, directed change, open problems, and supplier reliability program activity is presented at RSRM Program Team Meetings and appropriate NASA reviews. When prepared, meeting handouts and minutes are available to NASA. All Reliability status information is provided to NASA as requested.

2.1.5 SUPPLIER SELECTION AND CONTROL

System Safety participates in the selection of subcontractors by processing a Quality Assurance Vendor Approval/Waiver Request. Procurement (Buyer) generates this request for a subcontractor not needing a Pre-Award Survey. The Thiokol Space Operations GIDEP office reviews the subcontractor for an **"Alert"** history, and approves or disapproves the subcontractor. The GIDEP office may disapprove a subcontractor pending a Pre-Award survey as outlined in TWR-17926 or as outlined in section 2.1.3 of this plan.

System Safety participates in the control of subcontractors in two areas:

1. By establishing requirements on the Procurement Data' List (PDL). Requirements for the Reliability program are established on the' PDL before a request for Proposal/Request for Quotation (RFP/RFQ) is released to a subcontractor. The requirements evaluation considers the design, the impact of hardware failure

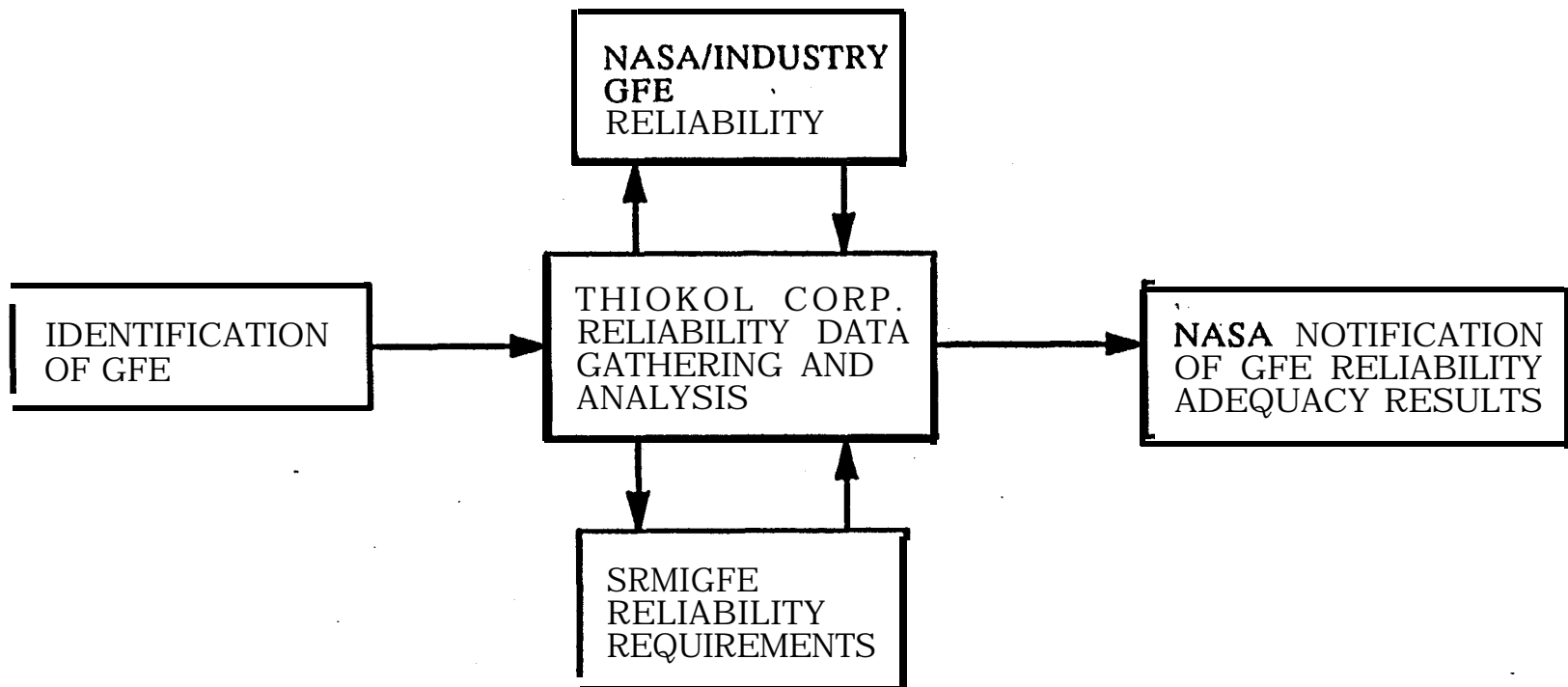


Figure 3. PROCEDURE FOR DETERMINING RSRM GFE RELIABILITY ADEQUACY

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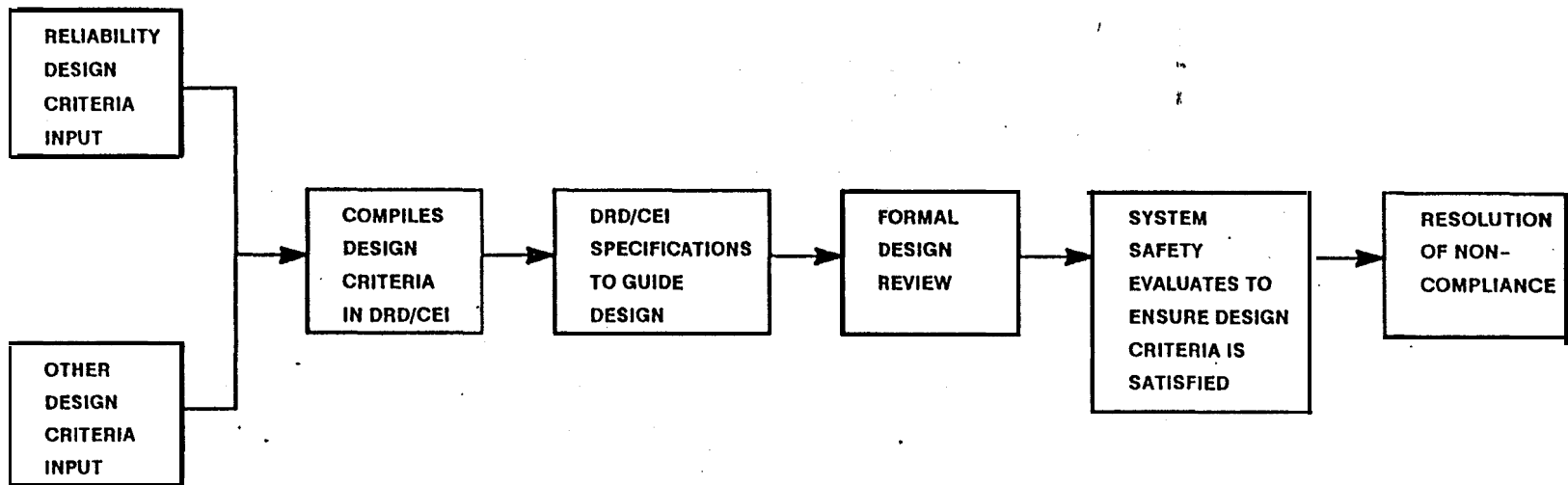


Figure 4. PROCEDURE FOR SYSTEM SAFETY RELIABILITY DESIGN CRITERIA INPUT AND IMPLEMENTATION

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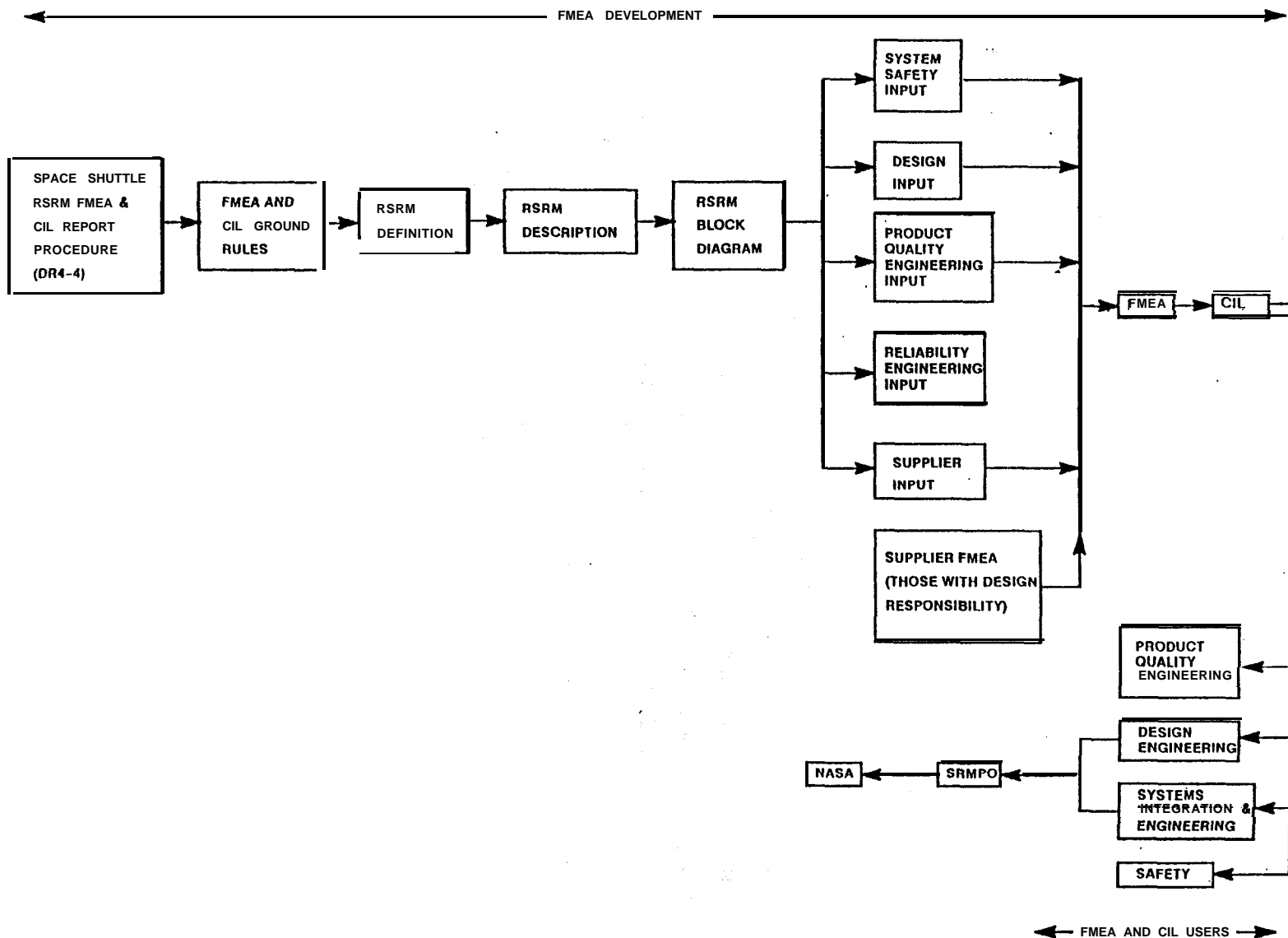


Figure 5. FMEA AND CIL INPUT, ANALYSIS, AND DISTRIBUTION FLOW

SAC009/FD

source documents to System Safety for hazards analysis and **Quality Assurance** for inspection requirements. Figure 5 illustrates the RSRM **FMEA** and CIL preparation flow from the procedure input through distribution.

The FMEA and CIL from Thiokol and the suppliers are combined into **one** document and presented to NASA: The combined report complies with the requirements and definitions of NHB-5300.4. **(1D-2)** and DPD 400, DR 4-3. The, **FMEA/CIL** is updated as necessary.

A separate **FMEA/CIL** for GSE is not required where a hazard analysis was prepared to the detail necessary to verify **the "fail safe"** requirement of NSTS 07700 Vol. X (NASA memo **SA42-516-88-JT**). The hazard analysis is prepared by System Safety per TWR-15902. The information contained in the hazard analysis is available for NASA review upon request.

2.2.4 RELIABILITY-MAINTAINABILITY INTERFACE

System Safety coordinates with Space Engineering as necessary to support the RSRM Program.

Limited-life items (**LLIs**) and Line Replaceable Units (**LRUs**) are identified in the **FMEA/CIL**. **The scope of** LLI identification, selection and regulation is restricted to, criticality 1 and **1R items**.

2.2.5 DESIGN REVIEW AND READINESS REVIEW

System Safety participates in all internal **RSRM** design reviews, Configuration Control Board (CCB) meetings, suppliers Preliminary Design Reviews (PDR), **Critical Design** Reviews (CDR), Operations Change Requests, (OCR), and Flight Readiness Reviews (FRR).

At the Internal Design Reviews, System Safety ensures that the design meets all reliability-imposed design criteria in the RSRM CEI Specification and Design Requirements Document (DRD). Verification that the design meets reliability design criteria is accomplished by

signature approval. System Safety also ensures the design minimizes the probability of the occurrence of failure modes identified in the FMEA. Components with failure modes listed in the CIL receive special attention and review.

FMEA/CIL requirements are incorporated into planning as shown in Figure 6. Reliability Engineering identifies inspections pertinent to new CILs and changed CILs. Changes may be from Engineering (drawings, specifications, TWR, etc.) or Quality Manufacturing (OCRs). Reliability Engineering reviews all changes for FMEA/CIL impact. When there is impact, CIL codes are assigned to new inspections or the change is made to existing ones. NASA Level III approval is obtained. Quality Engineering adds the CIL codes or changes to the Master Inspection Plan (MIP) or Common Planning Index (CPI), whichever is applicable. The CIL codes are then transferred into the Receiving Inspection Plan (RIP); Vendor Inspection Plan (VIP), or Shop Traveler. Reliability Engineering audits the planning to verify the CIL codes are in place.

System Safety is a member of the RSRM Configuration Control Board (CCB) and reviews and approves all CCB documentation through the Quality and Reliability Assurance document coordinator. System Safety relationship with the CCB is presented in Figure 7. As a member of the CCB, System Safety also reviews and approves Operations Change Requests (OCRs) through the Quality and Reliability Assurance document coordinator. System Safety approves all Type I and II changes, and all Type III changes that affect FMEA/CIL coded requirements. System Safety's role in the control of planning changes is defined in Management Procedure 66-02-01. System Safety initiates proposed CIL changes, and submits such changes to one or more of the following organizations for review, as applicable: Space Engineering, Program Management, System Safety, Manufac-

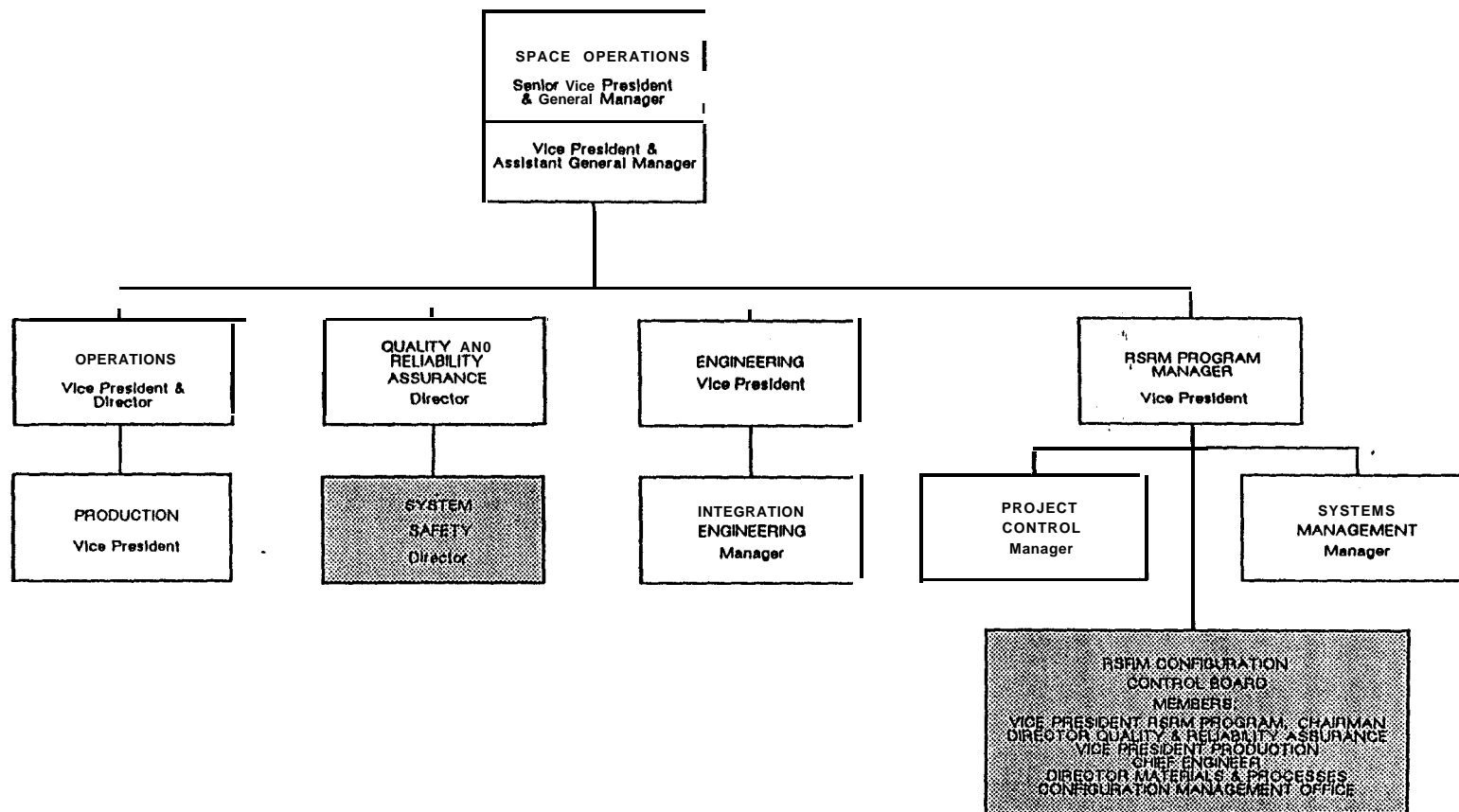


Figure 7. FUNCTIONAL RELATIONSHIP OF SYSTEM SAFETY TO THE RSRM CONFIGURATION CONTROL BOARD

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LEGEND

CAR - Corrective Action Request
CPR - Candidate Problem Report
C/A - Corrective Action
DR - Discrepancy Report
L/P R- Liaison Problem Reporting
MRB - Material Review Board

PD - Process Deviation
PE - Project Engineering
PFAR - Post-Fire Anomaly Report
PR - Problem Report (KSC)
SPR - Significant Problem Report
SRMPO - Solid Rocket Motor Program Office
TWR - Thiokol Wasalch Report

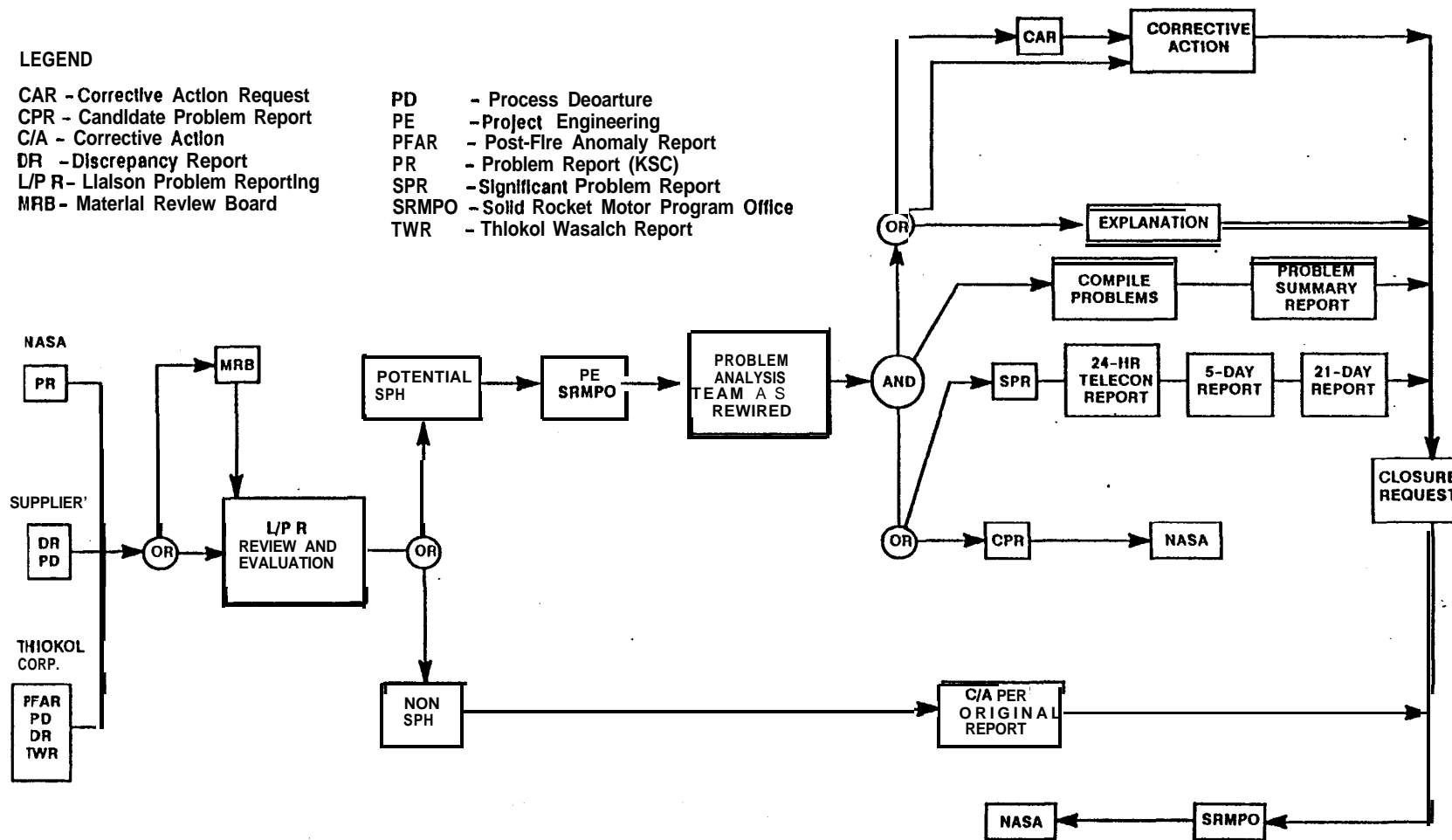


Figure 8. RSRM PROBLEM REPORTING AND CORRECTIVE ACTION SYSTEM

SAC003/FDa

- 0 Problems which are borderline in meeting the DPD-400 requirement are documented as candidate problem reports (CPR). Copies of the CPR are distributed to the Cognizant Project Engineer and the Hardware Program Manager. A copy of the CPR is also telefaxed to Calspan/MSFC and the original maintained on file in the Liaison/ Problem Reporting section. After MSFC review, the **CPR's** that need to be elevated through the PAS system are prepared as a Significant Problem Report (SPR) as requested by MSFC. If the problem is not elevated to a SPR, the originating report documenting the CPR **anomaly** (e.g., DR, KSCPR, etc.) provides required corrective action.

2.2.7 REPORTING AND RESOLVING GIDEP PARTS AND MATERIALS PROBLEMS (ALERTS)

System Safety coordinates the Alert program for Thiokol Space Operations and Space Operations suppliers. When System Safety receives an Alert from NASA or GIDEP, the Alert is dispositioned as illustrated in Figure 9. System Safety performs an in-house investigation of **all** Alerts to determine applicability and impact to the RSRM project. Corrective action or flight rationale is proposed to MSFC as required. Supplier furnished parts and material lists are also reviewed, and the Alert sent to the supplier if appropriate. Each supplier receiving an Alert is required to respond in writing within 10 days. A response **may** be required sooner if a scheduled launch is **pending**. The results of these in-house and supplier investigations are forwarded to NASA per DR 4-7 of DPD 400.

System Safety coordinates the initiation of all RSRM Program Alerts. An Alert may be generated by suppliers with design responsibility, Thiokol Quality Assurance, Safety, Manufacturing, Procurement, and System

Safety under the direction of the Space Operations GIDEP office. The GIDEP Office reviews pertinent information from available documentation and suppliers to identify potential Alerts. Following review by the Program Office and the affected supplier, the Alert is prepared for review by the NASA Alert Coordinator at MSFC who approves it for release **into, the** GIDEP System. All Alerts initiated by Space Operations must be in compliance with DR 4-7 of DPD. 400 and GIDEP Policies and Procedures.

2.2.8 ELECTRICAL, ELECTRONIC, AND ELECTROMECHANICAL PART CONTROL

Thiokol and its suppliers with design responsibility identify and select Electrical, Electronic, and Electromechanical (EEE) parts by using NASA reference document MSFC-DWG-85M03936 or MIL-STD-975 as changed by approved deviation RDW-0571 or Nonstandard Part Approval Requests (**NSPARs**) as applicable. This selection process is to promote the use of standard-part types with proven reliability and quality standards and to minimize the number of part types used. Deviations and substitutions are written against the **85M03936** or MIL-STD-975 documents and are submitted for NASA approval. TWR-63719 contains a list of EEE parts for the RSRM Project.

Problems with EEE parts are reported via **SPRs**, the Problem Summary Report, or **DRs** as appropriate;

2.2.9 MATERIAL SPECIFICATION AND APPLICATION REVIEWS

Thiokol and its suppliers with design responsibilities ensure that materials selected, for the RSRM meet NASA requirements. System Safety provides input to material application and specification reviews through review of material use agreements (**MUAs**), waivers, deviations, engineering drawings, specifications, and changes thereto.

Thiokol suppliers with design responsibility conduct reviews of applicable material, as required by **STW7-3748**.